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(12) **United States Patent**
Jändel

(10) **Patent No.: US 6,763,371 B1**
(45) **Date of Patent: Jul. 13, 2004**

(54) **METHOD AND APPARATUS FOR COLLABORATIVE COMMUNICATION IN A COMMUNICATION NETWORK**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/307,712**

(22) Filed: **May 10, 1999**

(51) **Int. Cl.**[7] **G06F 15/16**; G06F 17/00; H04L 12/16

(52) **U.S. Cl.** **709/204**; 709/203; 370/260; 463/42

(58) **Field of Search** 709/203, 204, 709/207, 223, 225, 213; 345/717, 733, 736, 748, 753; 370/260, 466; 463/42

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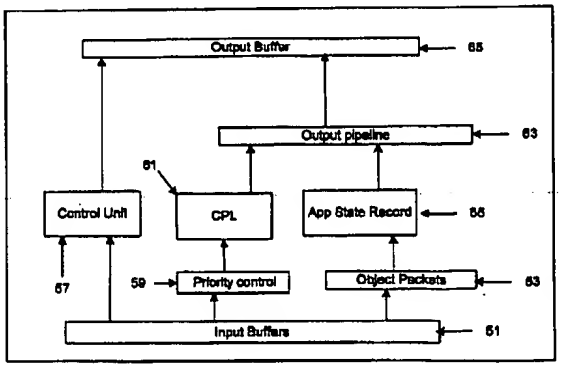
Primary Examiner—Jason D. Cardone

(57) **ABSTRACT**

The real-time performance in communications networks is improved, especially between a large number of participants, by a server unit having a device for receiving information from at least a client unit, the information including at least part of the state information about a distributed interactive application. The server unit includes a device for storing application state information received from at least one client unit, and a device for forwarding the state information received from the client to at least one other node in the network and for transmitting at least part of the information stored in the state information storing device to the at least one client. In this way, the whole state of the application can be kept in one or more units in the network, which removes the need for each client to store the entire state, thereby reducing memory and bandwidth requirements for each client.

17 Claims, 3 Drawing Sheets



US006411617B1

(12) **United States Patent**
Kilkki et al.

(10) **Patent No.: US 6,411,617 B1**
(45) **Date of Patent: Jun. 25, 2002**

(54) **SYSTEM AND METHOD FOR MANAGING DATA TRAFFIC ASSOCIATED WITH VARIOUS QUALITY OF SERVICE PRINCIPLES USING A CONVENTIONAL NETWORK NODE SWITCH**

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(73) Assignee: **Nokia Telecommunications, Oy**, Espoo (FI)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/209,138**

(22) Filed: **Dec. 10, 1998**

(51) **Int. Cl.**[7] **H04L 12/56**
(52) **U.S. Cl.** **370/353**; 370/395.42
(58) **Field of Search** 370/395, 389, 370/229–240, 351, 352, 535, 537, 399, 428, 254, 252, 395.57, 395.31, 395.32, 395.42, 400, 401, 402, 412, 411, 444, 455, 353

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(List continued on next page.)

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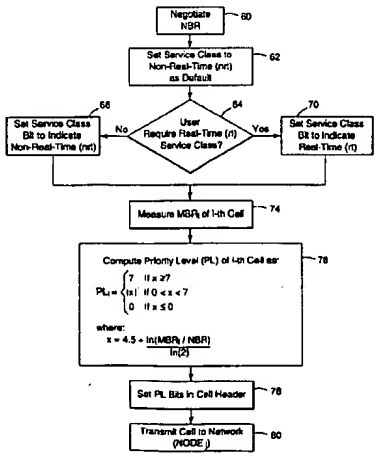
(57) **ABSTRACT**

A system and method for communicating first data packets having a first quality of service over a network system designed for communicating second data packets having a second quality of service. The network system includes a plurality of network nodes, where each of the network nodes includes a network switch. The first data packets are switched from each of a plurality of network switch input ports to a dedicated output port of the network switch. Network node congestion control is applied to the first data packets at the dedicated output port to selectively accept or discard the first data packets in accordance with their respective quality of service acceptance principles. Those of the first data packets that were accepted are multiplexed into one or more virtual paths having common output port destinations, and the virtual paths are input into a dedicated input port of the network switch. The virtual paths at the dedicated input port are switched to output port destinations of the network switch identified by the common output port destinations.

18 Claims, 9 Drawing Sheets



US006181699B1

(12) **United States Patent**
Crinion et al.

(10) **Patent No.: US 6,181,699 B1**
(45) **Date of Patent: Jan. 30, 2001**

(54) **APPARATUS AND METHOD OF ASSIGNING VLAN TAGS**

(75) Inventors: **Patrick T. Crinion**, San Jose; **Vickie Pagnon**, Sunnyvale, both of CA (US)

(73) Assignee: **National Semiconductor Corporation**, Santa Clara, CA (US)

(*) Notice: Under 35 U.S.C. 154(b), the term of this patent shall be extended for 0 days.

(21) Appl. No.: **09/108,873**

(22) Filed: **Jul. 1, 1998**

(51) **Int. Cl.**[7] **H04L 12/56**

(52) **U.S. Cl.** **370/392**; 370/389

(58) **Field of Search** 370/389, 395, 370/401, 428, 470, 400, 392; 711/216, 217, 218

(56) **References Cited**

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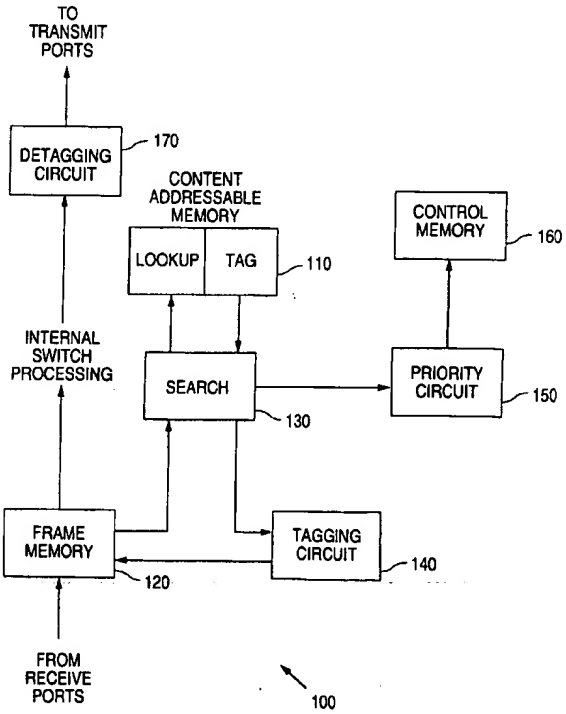
Assistant Examiner—Ken Vanderpuye
(74) *Attorney, Agent, or Firm*—Limbach & Limbach L.L.P.

(57) **ABSTRACT**

An apparatus for and method of assigning a VLAN tag to a frame received at a port of a switch are disclosed. The apparatus includes a content addressable memory, a data frame memory, a search circuit, and a tagging circuit. The content addressable memory stores tagging information, the tagging information including lookup data and associated tag data. The frame memory stores at least part of a data frame, the part including data frame information. The search circuit is connected to the content addressable memory and the data frame memory. The search circuit reads the data frame information, searches the content addressable memory for the lookup data corresponding to the data frame information, and reads a corresponding subset of the associated tag data. The tagging circuit is connected to the search circuit and the data frame memory. The tagging circuit writes in the data frame memory a VLAN tag including the corresponding subset of the associated tag data.

16 Claims, 7 Drawing Sheets



US006757297B1

(12) **United States Patent**
Chin

(10) **Patent No.: US 6,757,297 B1**
(45) **Date of Patent: Jun. 29, 2004**

(54) **METHOD AND APPARATUS FOR DYNAMIC CONFIGURATION AND CHECKING OF NETWORK CONNECTIONS VIA OUT-OF-BAND MONITORING**

(75) Inventor: **Hon Wah Chin**, Palo Alto, CA (US)

(73) Assignee: **Ciena Corporation**, Linthicum, MD (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/321,979**

(22) Filed: **May 28, 1999**

Related U.S. Application Data

(63) Continuation-in-part of application No. 09/225,920, filed on Jan. 5, 1999.

(51) **Int. Cl.**[7] **H04J 1/16**; H04J 3/14

(52) **U.S. Cl.** **370/469**; 370/221; 370/225

(58) **Field of Search** 370/216, 217, 370/218, 221, 222, 225, 226, 255, 256, 469; 709/249, 221, 225, 250

(56) **References Cited**

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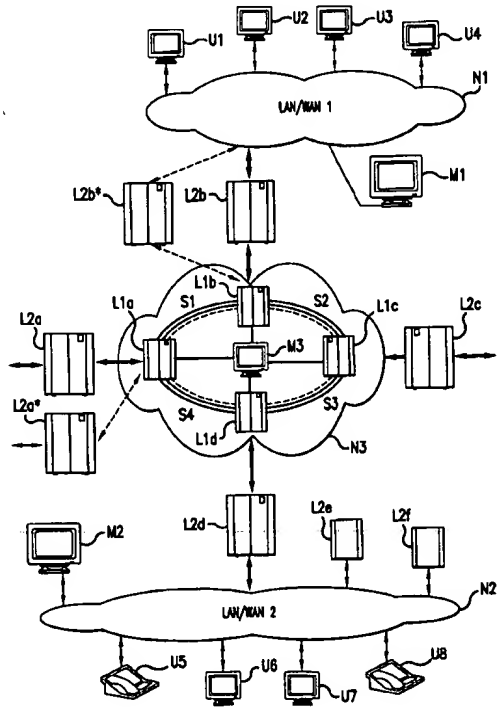
Assistant Examiner—William Schultz
(74) *Attorney, Agent, or Firm*—Michael R. Cammarata; Stephen J. LeBlanc

(57) **ABSTRACT**

A first network element includes or is associated with a query engine that allows it to retrieve operating parameters from a second network element even when the first and second network elements are not participating in a common routing protocol. The first element is thereby able to determine if the second network is operational and to take action to reroute data to a backup element if the second element is not operational.

19 Claims, 4 Drawing Sheets



US-PAT-NO: 6757297

DOCUMENT-IDENTIFIER: US 6757297 B1

TITLE: Method and apparatus for dynamic configuration and checking of network connections via out-of-band monitoring

DATE-ISSUED: June 29, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Chin; Hon Wah	Palo Alto	CA	N/A	N/A

US-CL-CURRENT: 370/469, 370/221 , 370/225

ABSTRACT:

A first network element includes or is associated with a query engine that allows it to retrieve operating parameters from a second network element even when the first and second network elements are not participating in a common routing protocol. The first element is thereby able to determine if the second network is operational and to take action to reroute data to a backup element if the second element is not operational.

19 Claims, 5 Drawing figures

Exemplary Claim Number: 1

Number of Drawing Sheets: 4

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Application Filing Date - AD (1):
19990528

Brief Summary Text - BSTX (5):
Modem networks operate according to a layered network protocol suite. One
published model for a typical protocol suite is known as the International Standards Organization (ISO) Open Systems Interconnection (OSI) reference
model. In the OSI model, networking functions are divided into roughly seven
layers, which from the lowest layer to the highest layer may be referred to as:
(1) the physical layer, (2) the data link layer, (3) the network layer, (4) the transport layer, (5) the session layer, (6) the presentation layer, and (7) the application layer. In some situations, Layer 1 (the physical layer) includes a number of sublayers. These sublayers may include a second, mostly independent,
generally high-speed, network with an independent layered protocol suite. Sublayer communication can include, for example, public data networks provided
by telephone companies or by internetwork service providers. One typical example of a sublayer is a high-speed optical network, such as SONET, that can
be used to provide distant physical layer links to a subscriber network. Another technology used for sublayer communications is ATM. A sublayer network
that provides physical layer connections to network elements in another network
is sometimes referred to as a subnetwork.

Brief Summary Text - BSTX (18):

In one embodiment, the invention utilizes an agent associated with an NE and capable of communicating operating parameters. There is a large installed base of such agents, typically in layer 3 (L3) network devices (such as routers). These agents are generally intended for communication with network management stations that report network operations to a human user. In prior art systems, existing installed agents are intended to facilitate configuration of the NE in which they are installed or with which they are associated, generally through intervention of a human network manager. According to an embodiment of the invention, a first NE, possibly one operating at a different network layer or a different network or subnetwork, uses the agents to learn about the success or failure of data handled by a second NE and to thereby infer the performance of the first NE. The first NE may then take configuration actions on itself or may use the agent in the second NE to affect the configuration of the second NE. This action may include such things as rerouting data from failed or overloaded communication channels, changing priorities, changing path costs, or establishing backup paths for heavily used communications channels.

Brief Summary Text - BSTX (19):

One area of particular interest for the invention is in sublayer communications using optical NEs. In such networks, it is desirable for the optical NEs to be able to detect channel defects without examining the optical signal in the channel, and the present invention provides a mechanism for these

NEs to detect trouble or failure in optical channels indirectly from other NEs.

Brief Summary Text - BSTX (21):

With the advent of higher speed network transmissions (such as optical transmissions) and optical layers with intelligence, the burden of analyzing a payload channel for control information, relative to the forwarding of the payload itself, has increased. The burden of analysis is further increased in optical devices that can carry a multiplicity of optical payload data formats.

Brief Summary Text - BSTX (22):

Previously, a method and system using a standard network management protocol to exchange information between network layers to coordinate activities of a particular network layer was described. The present invention extends that approach to provide additional functions of detecting node failure and rerouting signals without examining a payload channel. In one embodiment, the present invention avoids building into lower layer or other layer NEs an ability to interpret or analyze a payload data signal, because control information intended for analysis by the other layer devices is not embedded in the same channel with payload data.

Brief Summary Text - BSTX (23):

One function an intelligent network layer according to the invention can provide is to redirect communications away from a failed network node device to a backup device for that node. The intelligent network layer is initially informed of the desired connectivity and the planned backup connectivity and provides the connection between the primary nodes. As discussed in the

above
referenced application, and herein, an intelligent layer according to the invention makes queries to other-layer network devices in order to detect a failure of the primary device and provide the backup connectivity. The present
invention has the advantage over prior art approaches in that it neither requires changes to the operation of other-layer network equipment, such as the
ability to parse new protocols, nor does it require analyzing and parsing the payload signal.

Detailed Description Text - DETX (4):

In either interpretation, each of the network clouds labeled N1 and N2 could
be understood as configurations of ethernet equipment, fiber optic equipment,
radio frequency mesh network equipment, LAN ATM equipment, or combinations of
technologies now existing or later developed to provide network communication.

Detailed Description Text - DETX (8):

FIG. 1 also shows spare NEs L2b* and L2a*. These spare NEs may represent
spare or backup physical devices that can be used in place of their corresponding devices, or these spare NEs can represent alternate data, paths
that can handle the traffic that would otherwise be carried by the primary NEs.
While in the figure, backup L2 NEs L2b* and L2a* are shown as being connected
to the same L1 NEs as the primary L2 NEs, it should be understood that in practice, the backup L2 NEs may be connected to different L1 NEs for greater
redundancy. For instance L2b* may be connected to L1c. L2 NEs which

are
database query servers could thereby be backed up by equipment at a different
site.

Detailed Description Text - DETX (17):
An underlying assumption in many network systems represented by FIG. 1 is
that the different groups (or in a specific embodiment, layers) of NEs are responsible within a group for ensuring communications are working properly. A
failure in the interconnection somewhere between L1 NEs, for example, is expected to be detected and corrected within that group.

Detailed Description Text - DETX (20):
In a particular embodiment, the invention uses SNMP and L1a includes an SNMP
query engine (which may include just a subset of SNMP MIB definitions). L1a
performs SNMP sets and gets to L2a-e or to any other NE with an SNMP agent for
which L1a knows the address. L1a can also receive standard format SNMP alarms.
L1a includes logic to determine from responses received from other NEs if a performance problem in L1a channels exists. Thereafter, L1a may reconfigure
itself and cause reconfiguration of other NEs. The present invention therefore
allows a group of NEs to coordinate its operation with another group of NEs using an existing network management protocol. (As used herein and in the claims, the term group should be understood to also encompass a group of one
unless the context requires otherwise.) It will be seen that management stations such as M1-3 are not required for operation of the invention, though

in one embodiment a management station could be used to respond to some queries
or to filter or forward data between L2 agents and the L1 NEs.

Detailed Description Text - DETX (29):
According to this embodiment of the invention, the L1 NEs are provided with
a data connection to the other devices for which they provide a communication
channel, either a direct channel, or via data forwarding between the L2 NEs, or
via data forwarding within the collection of L1 NEs.

Detailed Description Text - DETX (35):
A further example application for the invention is in the field of uninterruptible power supply (UPS) used to provide short term back up power to
an NE in case of a power failure. A UPS generally has a connection (such as an
RS232 serial cable) connected to a computer associated with the NE that informs
the NE that power has been lost and the UPS is running on batteries. The computer can therefore begin to shut down, if necessary, in a controlled fashion and can alert the NE that power is going down.

Detailed Description Text - DETX (39):
Another application for the invention, as discussed above, is in providing a
mechanism where traffic can be redirected to a backup other-group NE terminal
when the primary NE either fails, develops predefined performance problems, or
has some other predefined operating status such as excessive congestion. The

steps taken by a group of network devices, such as L1 devices shown in FIG. 1,
according to an embodiment of the invention are described below.

Detailed Description Text - DETX (40):
For the situation where NE L2a is connected to NE L2b by L1 NEs and NE L2a
is backed up by NE L2a*, which can provide an alternative path for traffic through L2a, if L2a fails, NE L2b should be connected to NE L2a*. An L1 NE,
according to a further embodiment of the invention and as shown in FIG. 4, will
perform as follows:

Detailed Description Text - DETX (46):
For the situation where NE L2a is connected to NE L2b by L1 NEs and NE L2a
is backed up by NE L2a* and NE L2b is backed up by NE L2b*, if L2a fails, NE
L2b or L2b* should be connected to NE L2a* and if L2b fails, NE L2a or L2a*
should be connected to NE L2b*. An L1 NE, according to a further embodiment of
the invention, will perform as follows:

Detailed Description Text - DETX (64):
In typical installations, L1 Optical Transport Layer Equipment (OTLE) can
communicate with L2 equipment at the same site via a local connection (such as
a LAN) at the site. This LAN is generally a separate network from the optical
data channel that generally carries more-distant, WAN traffic. To communicate

with remote, L2 equipment, an L1 NE according to the invention must find a path
to the remote L2 device. Because the set of L1 equipment forms a network, the
local L1 device can communicate with a remote L1 device and have that remote L1
device forward the network management request to the remote L2 device. An
internal request may be launched by the local L1 device over the L1 subnetwork
addressed to the remote L1 device, forwarded by a routing algorithm used by the
L1 subnetwork. The remote L1 device can then form a standard management
request using the format and addressing of the LAN used at the remote location
and forward that request to the remote L2 device.

Detailed Description Text - DETX (65):

The local L1 device can also launch query packets to the remote L2 device through its local LAN to the local L2 device. These packets may be launched
instead of packets sent through the L1 connections or in addition to those packets. In this case, the packets can then take advantage of any path diversity built into the L2 network. In some instances the local L2 device will reformat the packet for WAN communications and place the packet back onto
the L1 provided data channel for transmission. In other cases, a different available path may be used at the L2 level.

Claims Text - CLTX (12):

12. The method according to claim 7 wherein transmission via elements in
the first network layer group is directed by bridge forwarding over a spanning

tree.

Claims Text - CLTX (13):
13. The method according to claim 1 wherein said first network layer element transmits to a remote second network layer element by sending on its
local link connected to local second network layer elements packets in the network management protocol used by the second network layer elements and
utilizing the forwarding function of the second network layer to forward the packets to the remote second network layer element.

Claims Text - CLTX (15):
15. The method of claim 1 further comprising: storing information regarding
the identity of the second network layer element and the responses received by
the request engine.

Claims Text - CLTX (16):
16. The method of claim 1 wherein the first network layer is a physical layer and the second network layer is a data link layer.

Claims Text - CLTX (18):
18. An optical network for providing network data communications among a
plurality of served nodes, said optical network comprising: at least one optical element; a plurality of optical channels, said optical element and optical channels configurable to provide a plurality of optical connections; said optical element including a database that stores information regarding the
identity of served nodes for a connection and the identity and routing path for

backup nodes for said served nodes; said optical element including a request
engine that generates queries in a network management protocol to management
agents at said served nodes, said queries regarding operational status of a served node or of a connection seen by a served node and for receiving responses from said served nodes, said optical element is in a first network layer and said served node is in a second network layer, the first and second network layers being part of a hierarchical arrangement of network layers, wherein the first network layer provides different networking functions than the second network layer; said optical network element including an inference
engine that determines, from said responses, whether a served node has developed a predefined operating status; and said optical element including reconfiguration circuits that can route traffic directed to a node with said predefined operating status to an alternative path wherein said requests are transmitted using an SNMP network management protocol and said management
agents are SNMP agents.